IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

First Named Inventor :	William R. Priedeman, Jr.	
Appln. No.:	10/511,784	Confirmation No.: 4209
Filed :	October 15, 2004	Group Art Unit: 1791
For :	Smoothing Method For Layered Deposition Modeling	Examiner: John L. Goff II
Docket No.:	S697.12-0065	

BRIEF FOR APPELLANT

FILED ELECTRONICALLY ON AUGUST 3, 2010

This is an appeal from a Final Office Action dated February 3, 2010, and an Advisory Action dated May 24, 2010, in which claims 1, 3-5, 8, 10, 11, 18, 20-23, 27, 28, 33, 43, and 45-49 were finally rejected.

REAL PARTY IN INTEREST

Stratasys, Inc., a corporation organized under the laws of the state of Delaware, and having offices at 7665 Commerce Way, Eden Prairie, MN 55344, has acquired the entire right, title and interest in and to the invention, the application, and any and all patents to be obtained therefor.

RELATED APPEALS AND INTERFERENCES

There are no related appeals that may directly affect or be directly affect by or have a bearing on the Board's decision in this appeal.

STATUS OF THE CLAIMS

I.	Total number of claims in the application		
	Claims in the application are:		1-49
II.	Status of all the claims		
	A.	Claims canceled:	2, 6, 7, 9, 12-17, 24-26, 34-42, and 44
	B.	Claims withdrawn but not canceled:	none
	C.	Claims pending:	1, 3-5, 8, 10, 11, 18, 20-23, 27, 28, 33, 43, and 45-49
	D.	Claims allowed:	none
	E.	Claims rejected:	1, 3-5, 8, 10, 11, 18, 20-23, 27, 28, 33, 43, and 45-49
	F.	Claims objected to:	none
III.	Claims on appeal		
	The claims on appeal are:		1, 3-5, 8, 10, 11, 18, 20-23, 27, 28, 33, 43, and 45-49

STATUS OF AMENDMENTS

Applicants filed an Amendment After Final on May 3, 2010, in which claims 1, 21, and 43 were amended, and claims 16, 19, and 44 were canceled. The Examiner then submitted an Advisory Action on May 24, 2010, which stated that, for purposes of appeal, the amendments will be entered. The Advisory Action also maintained the rejections of pending claims 1, 3-5, 8, 10, 11, 18, 20-23, 27, 28, 33, 43, and 45-49.

SUMMARY OF CLAIMED SUBJECT MATTER

The present invention, as set forth in <u>independent claim 1</u>, is a method for making a three-dimensional object (10). The method includes providing an object (10) built from a polymeric or wax modeling material using a fused deposition modeling technique (present

application, page 4, lines 27-29; and page 5, lines 24-30). The built object has an object surface (12, 14, 16, 18) formed of the modeling material (present application, page 5, line 32 to page 6, line 2). The object surface (12, 14, 16, 18) has at least one surface effect due to the fused deposition modeling technique, where the at least one surface effect extends substantially across an entirety of the object surface (12, 14, 16, 18) (present application, FIG. 1; page 2, lines 16-30; page 5, line 24 to page 6, line 2; and page 6, lines 17-20). The at least one surface effect is selected from the group consisting of a stair step effect (present application, FIG. 1; page 2, lines 18-22; and page 6, lines 17-18), striation (present application, FIG. 1; page 2, lines 16-18; and page 6, line 20), a roughness due to errors in building the object (10) (present application, FIG. 1; page 2, lines 23-30; and page 6, line 20), and a combination thereof.

The object (10) exhibits porosity due to the fused deposition modeling technique (present application, page 6, lines 23-26 as amended in Applicant's Amendment of November 18, 2009, which was accepted by the Examiner in the Final Office Action of February 3, 2010). The method also includes exposing the object (10) to vapors of a solvent that transiently softens the modeling material at the object surface (12, 14, 16, 18) (present application, FIG. 2, page 8, lines 10-16). The method further includes reflowing the softened modeling material to substantially eliminate the at least one surface effect and to substantially eliminate the porosity of the object (10) at the object surface (12, 14, 16, 18) (present application, FIG. 2, page 8, lines 10-16; and page 8, lines 18-24 as amended in Applicant's Amendment of November 18, 2009, which was accepted by the Examiner in the Final Office Action of February 3, 2010).

The present invention, as set forth in <u>independent claim 21</u>, is a method for making a three-dimensional object (10), where the method includes providing an object (10) built from a plurality of layers with a modeling material using a fused deposition modeling technique (present application, page 4, lines 27-29; and page 5, lines 24-30). The object (10) has an object surface (12, 14, 16, 18), where the plurality of layers create at least one surface effect extending substantially across an entirety of the object surface (12, 14, 16, 18) (present application, FIG. 1; page 2, lines 16-30; page 5, line 24 to page 6, line 2; and page 6, lines 17-20). The at least one surface effect being selected from the group consisting of a stair step effect (present application, FIG. 1; page 2, lines 18-22; and page 6, lines 17-18), striation (present application, FIG. 1; page 2, lines 16-18; and page 6, line 20), a roughness due to errors in building the object (10) (present application, FIG. 1; page 2, lines 23-30; and page 6, line 20), and a combination thereof.

The object (10) exhibits porosity due to the fused deposition modeling technique (present application, page 6, lines 23-26 as amended in Applicant's Amendment of November 18, 2009, which was accepted by the Examiner in the Final Office Action of February 3, 2010). The method also includes exposing the object (10) to vapors of a solvent that transiently softens the modeling material at the object surface (12, 14, 16, 18) (present application, FIG. 2, page 8, lines 10-16). The method further includes reflowing the softened modeling material to substantially eliminate the at least one surface effect substantially across the entirety of the object surface 12, 14, 16, 18) and to substantially eliminate the porosity of the object at the object surface 12, 14, 16, 18) (present application, FIG. 2, page 8, lines 10-16; and page 8, lines 18-24 as amended in Applicant's Amendment of November 18, 2009, which was accepted by the Examiner in the Final Office Action of February 3, 2010).

The present invention, as set forth in <u>independent claim 43</u>, is a method for treating a three-dimensional object (10) built with a modeling material using a fused deposition modeling technique (present application, page 4, lines 27-29; and page 5, lines 24-30). The method includes providing the three-dimensional object (10) to a vessel (30) configured to contain vapors of a solvent (present application, page 6, line 27 to page 7, line 4). Substantially an entire exterior surface (12, 14, 16, 18) of the three-dimensional object (10) comprises at least one surface effect caused by the fused deposition modeling technique (present application, FIG. 1; page 2, lines 16-30; page 5, line 24 to page 6, line 2; and page 6, lines 17-20). The at least one surface effect is selected from the group consisting of a stair-step effect created by layering of a plurality of layers of the modeling material (present application, FIG. 1; page 2, lines 18-22; and page 6, lines 17-18), striation created by formation of roads of the modeling material (present application, FIG. 1; page 2, lines 16-18; and page 6, line 20), surface roughness created by errors in the building of the three-dimensional object (10) (present application, FIG. 1; page 2, lines 23-30; and page 6, line 20), and a combination thereof.

The object (10) exhibits porosity due to the fused deposition modeling technique (present application, page 6, lines 23-26 as amended in Applicant's Amendment of November 18, 2009, which was accepted by the Examiner in the Final Office Action of February 3, 2010). The method also includes placing the three-dimensional object (10) in the vessel (30) in a manner that exposes substantially the entire exterior surface (12, 14, 16, 18) of the three-dimensional object (10) to the vapors of the solvent, where the vapors of the solvent transiently soften the

modeling material across the entire exposed exterior surface (12, 14, 16, 18) of the three-dimensional object (10) (present application, FIG. 2, page 8, lines 10-16; page 6, line 27 to page 7, line 4). The method further includes reflowing the softened modeling material to substantially eliminate the at least one surface effect across the entire exposed exterior surface (12, 14, 16, 18) and to substantially eliminate the porosity of the object (10) at the object surface (12, 14, 16, 18) (present application, FIG. 2, page 8, lines 10-16; and page 8, lines 18-24 as amended in Applicant's Amendment of November 18, 2009, which was accepted by the Examiner in the Final Office Action of February 3, 2010).

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Claims 1-3, 8, 10, 11, 18, 21, 22, 27, 28, 33, 43, 45, and 47-49 stand rejected as being obvious over the specification of the present application (pages 1-4 and 8) as exemplified in part by Crump, U.S. Patent No. 5,121,329 ("Crump") in view of Joseph et al., U.S. Patent No. 3,807,054 ("Joseph") or Edmonds, U.S. Patent No. 5,448,838 ("Edmonds"), and optionally, Batchelder, U.S. Patent No. 5,652,925 ("Batchelder").

Claims 4, 5, 23, and 46 stand rejected as being obvious over the specification of the present application as exemplified in part by Crump in view of Joseph/Edmonds and optionally Batchelder, and further in view of Dahlin et al., U.S. Patent No. 6,022,207 ("Dahlin").

Claim 20 stands rejected as being obvious over the specification of the present application as exemplified in part by Crump in view of Joseph/Edmonds and optionally Batchelder, and further in view of Leyden et al., U.S. Patent No. 5,143,663 ("Leyden").

Claims 18 and 48 stand rejected as being obvious over the specification of the present application as exemplified in part by Crump in view of Joseph/Edmonds and optionally Batchelder, and further in view of Gessner, U.S. Patent No. 4,983,223 ("Gessner").

ARGUMENT

I. Claims 1-3, 8, 10, 11, 18, 21, 22, 27, 28, 33, 43, 45, and 47-49

The Final Office Action indicated that claims 1-3, 8, 10, 11, 18, 21, 22, 27, 28, 33, 43, 45, and 47-49 stand rejected as being obvious over the specification of the present application (pages 1-4 and 8) as exemplified in part by Crump in view of Joseph or Edmonds, and Batchelder. These rejections were maintained in the Advisory Action.

Independent claims 1, 21, and 43 are each directed to a method that recites providing a three-dimensional object built using a fused deposition modeling technique. As illustrated in FIG. 1 of the present application (reproduced below), three-dimensional objects built using the fused deposition modeling technique exhibit one or more surface effects due to the fused deposition modeling technique, where the surface effect(s) may extend substantially across an entirety of the object surface (claim 43 recites an "exterior surface") (present application, FIG. 1; page 2, lines 16-30; page 5, line 24 to page 6, line 2; and page 6, lines 17-20).

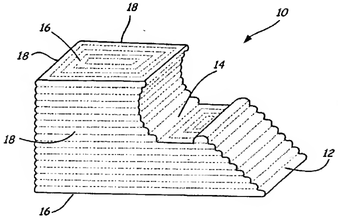

FIG. 1

For example, the object surface may exhibit stair-step effects created by the formation of successive layers, such as shown across angled surface 12 and curved surface 14 (present application, FIG. 1; page 2, lines 18-22; and page 6, lines 17-18). Additionally, the object surface may exhibit striation (e.g., texturing) created by formation of roads of the modeling material, such as shown across horizontal surfaces 16 and vertical surfaces 18 (present application, FIG. 1; page 2, lines 16-18; and page 6, line 20). Furthermore, the object surface may also exhibit roughness in one or more locations due to errors in building the three-dimensional object with the fused deposition modeling technique (present application, FIG. 1; page 2, lines 23-30; and page 6, line 20).

Pursuant to the method of claims 1, 21, and 43, the three-dimensional object may be exposed to vapors of a solvent that transiently soften the modeling material at the object surface, and the softened modeling material may reflow to substantially eliminate the surface effect(s) to provides a smooth surface (present application, FIG. 2, page 8, lines 10-16).

In addition, claims 1, 21, and 43 each also recite that the object exhibits porosity due to the fused deposition modeling technique, and that the steps of exposing the object to vapors of a solvent and reflowing the softened modeling material also substantially eliminate the porosity of the object at the object surface. As stated in the Declaration of Robert L. Zinniel ("Zinniel Declaration") and in the Declaration of Francisco Medina ("Medina Declaration"), the porous regions are inherent in 3D object built with the fused deposition modeling technique due to the build technique (see e.g., Zinniel Decl. ¶ 10). The pores are created to provide a cushion in the build parameters when depositing the modeling material to maintain the dimensional accuracy of the 3D object, as discussed in Batchelder (U.S. Patent No. 5,653,925) (Zinniel Decl. ¶ 10).

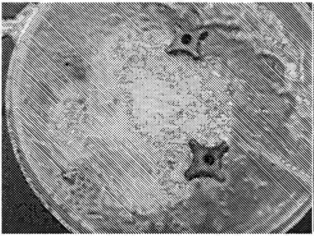

Image 5

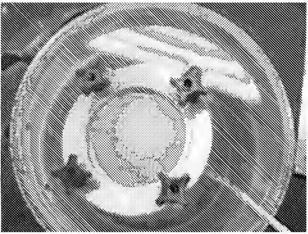

Image 6

The claimed method of exposing the object to solvent vapors that transiently soften the modeling material at the object surface and reflowing the softened modeling material also substantially eliminates the porosity of the three-dimensional object at the object surface (Zinniel Decl. ¶ 2, and Medina Decl. ¶ 2). This is illustrated by comparing Images 5 and 6 of the Zinniel Declaration (reproduced above), where Image 5 shows a three-dimensional object built using the fused deposition modeling technique prior to the claimed smoothing method, and Image 6 shows the 3D object after being subjected to the claimed smoothing method (Zinniel Decl., ¶¶ 9-11).

In comparison, when an identical three-dimensional object built using the fused deposition modeling technique was subjected to hand sanding to smooth the surface of the three-dimensional object, the porosity was not substantially eliminated at the object surface (Zinniel Decl., ¶ 12). This is illustrated in Image 7 of the Zinniel Declaration (reproduced below).

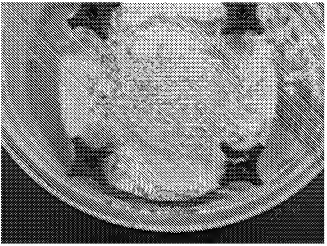

Image 7

Thus, the substantial elimination of the porosity at the object surface attained by the claimed method potentially seals the exposed area, which may create water-tight three-dimensional objects that can withstand pressure buildup (Zinniel Decl. ¶ 11, and Medina Decl. ¶ 2).

A. <u>Three-Dimensional Objects Built with the Fused Deposition Modeling Technique are Different from the Articles recited in Joseph and Edmonds</u>

Neither Joseph nor Edmonds disclose or suggest the use of three-dimensional objects built using the fused deposition modeling technique, or the substantial elimination of surface effects due to the fused deposition modeling technique. Joseph are Edmond each directed to the use of vaporized solvents on articles (e.g., telephone casings) to remove scratches, dents, blemishes, small voids, and the like (e.g., for refurbishing such articles) (see e.g., Joseph, col. 4, lines 42-48; and Edmonds, col. 2, lines 43-51 and col. 3, lines 1-8).

In the Final Office Action, the Examiner contends that there is a one-to-one correlation between the surfaces of the articles smoothed in Joseph and Edmonds and the surfaces of three-dimensional objects built with the fused deposition modeling technique. Furthermore, in the Advisory Action, the Examiner states that Joseph and Edmonds are generally directed to uniformly smoothing blemished surfaces of thermoplastic objects with vapors of a solvent, and that there is no teaching or suggestion that the vapor smoothing process would not perform the same on both types of objects.

As illustrated in FIG. 1 of the present application (reproduced above), the surface effects due to the fused deposition modeling technique extend substantially across the entire surface of

the three-dimensional object, including the bottom surface 16 (present application, FIG. 1; page 2, lines 16-30; page 5, line 24 to page 6, line 2; and page 6, lines 17-20). This differs from surfaces merely having defects such as scratches, dents, blemishes, and small voids, or that merely require polishing, as recited in Joseph and Edmonds.

Additionally, the Examiner has not provided any articulated reasoning as to why one skilled in the art would be motivated to modify the teachings in Joseph or Edmond to substantially eliminate surface effects due to the fused deposition modeling technique, and which extend substantially across the entire surface of the three-dimensional object. Indeed, as discussed in the present application, those skilled in the art have resorted to smoothing techniques such as manual trimming, machining or grinding, buffing with cloths, sand paper, or solution-born abrasives, and the like to smooth the surfaces of three-dimensional objects built using layered manufacturing rapid prototyping techniques, such as the fused deposition modeling technique (present application, page 3, lines 6-17).

Instead, the Examiner merely provides a conclusory statement that there is no teaching or suggestion that the process would not perform the same. This is not sufficient to establish a prima facie case for obviousness, particularly in view of Applicants' showing that those skilled in the art rely on techniques such as manual trimming, machining or grinding, buffing with cloths, sand paper, or solution-born abrasives, and the like. *See KSR Int'l Co. v. Teleflex, Inc.*, 550 U.S. 398, 82 U.S.P.Q.2d, 1385, 1396 (2007) (stating "rejections on obviousness cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness.").

B. <u>The Claimed Method Provides Unexpected Results</u>

The substantial elimination of the at least one surface effect and the substantial elimination of the porosity at the object/exterior surface are also unexpected results for three-dimensional objects built with the fused deposition modeling technique. In fact, solvent vapors <u>are not</u> suitable for smoothing objects built from all forms of layered manufacturing rapid prototyping techniques. For example, objects built with layered manufacturing rapid prototyping techniques such as the stereolithographic processes of Leyden use solvent vapors to remove excess resins (Leyden, col. 6, lines 56-68; col. 9, lines 34-39; and col. 11, lines 35-44). These processes require subsequent smoothing processes, such as applying and curing an additional

amount of the curable resin to fill in the surface discontinuities, to provide smooth surfaces (Leyden, col. 7, lines 1-15).

With respect to the substantial elimination of the porosity of the object at the object surface, the Final Office Action stated that the reduction in porosity as claimed by Applicants is not an unexpected result sufficient to overcome the prior art. The Examiner based this conclusion on two allegations: (1) that Joseph teaches the technique of filling voids with a solvent vapor process, and (2) that the Zinniel Declaration demonstrates that the admitted prior art as modified necessarily results in the reduced porosity.

With respect to the first allegation, the voids taught by Joseph are not porosity due to the fused deposition modeling technique. This is an erroneous conclusion made by the Examiner. The porosity due to the fused deposition modeling technique are pores entrained within the walls of the object. The mere fact that Joseph mentions that the solvent vapor process may be used to fill small voids does not teach or suggest to one skilled in the art that the claimed process in the present application may substantially eliminate porosity of the object at the object surface. In fact, when smoothing the surface of objects built with the fused deposition modeling technique to substantially eliminate porosity of the object at the object surface, voids and cavities that are intentionally formed during the build operation are desirably not filled during the claimed smoothing process.

In the Advisory Action, the Examiner stated that the claims are not commensurate in scope with this argument as the claims do not require any unfilled voids are cavities following the smoothing process. However, Applicants are not attempting to state that the three-dimensional objects necessarily have unfilled voids or cavities following the claimed vapor smoothing process. Rather, Applicants assert that the voids and cavities recited in Joseph are not porosity due to the fused deposition modeling technique. The porosity due to the fused deposition modeling technique are pores entrained within the walls of the object.

Furthermore, the statement that the Zinniel Declaration demonstrates that the admitted prior art as modified necessarily results in a reduced porosity erroneously mischaracterizes the Zinniel Declaration. The Zinniel Declaration expressly states that sealing effect at the surface of the 3D object would be recognized by people skilled in the art of rapid prototyping/manufacturing processes *based on the teachings in U.S. Patent Application No. 10/511,784 (the present application)* (Zinniel Decl., ¶ 11) (emphasis added). The Zinniel

Declaration <u>does not</u> demonstrate that the admitted prior art as modified necessarily results in substantially eliminating porosity of the object at the object surface.

In the Advisory Action, the Examiner stated that it is not clear why the admitted prior art as modified does not necessarily result in the reduced porosity. Applicants believe that the confusion with this issue centers around the meaning of the phrase "as modified". The Examiner did not elaborate which reference is being relied upon for the modification. Applicants assert that the Zinniel Declaration demonstrates that the admitted prior art as modified *by the teachings of the present application* necessarily results in substantially eliminating porosity of the object at the object surface. Thus, the Zinniel Declaration demonstrates that the substantial elimination of porosity of the object at the object surface is an unexpected result sufficient to overcome the prior art.

For example, as shown in Image 6 from the Zinniel Declaration (reproduced below), when the object was subjected to the claimed vapor smoothing process, the at least one surface effect and the porosity at the object surface were each substantially eliminated.

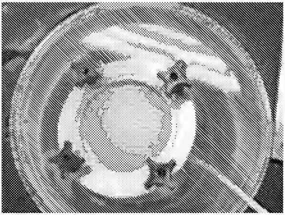

Image 6

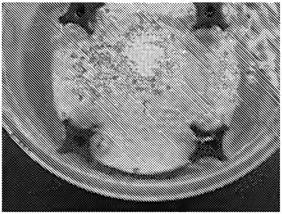

Image 7

In comparison, as shown in Image 7 from the Zinniel Declaration (reproduced above), when an identical object was subjected to hand sanding, the porosity of the object surface <u>was not</u> substantially eliminated, thereby allowing air and liquids to flow through the walls of the object. Accordingly, the Examiner provides no sufficient basis that rebuts Applicants' assertion that the substantial elimination of the surface effect(s) and the substantial elimination of the porosity of the object at the object surface are unexpected results.

C. The Claimed Process Satisfies a Long-Felt Need for Smoothing Objects Built with the Fused Deposition Modeling Technique

Layered manufacturing rapid prototyping techniques have been around for over 20 years. In fact, the assignee of the present application filed a patent application in October, 1989 directed to the fused deposition modeling technique (issued as U.S. Patent No. 5,121,329), and the patent application for Batchelder, U.S. Patent No. 5,653,925 was filed in September, 1995. Due to their layer-by-layer nature, these layered manufacturing rapid prototyping techniques typically provide three-dimensional objects having surface effects, such as stair-step effects and striation effects, as discussed above.

While these surface effects typically do not affect the strengths of the three-dimensional objects, they do detract aesthetically (present application, page 2, lines 16-22). As such, there has been a long-felt need to eliminate the surface effects of three-dimensional objects built by layered manufacturing rapid prototyping techniques, including objects built by the fused deposition modeling technique. In fact, as discussed in the present application, attempts have been made to smooth the surfaces of such objects by manually trimming, machining, grinding, or buffing with cloths, sand paper, or solution-born abrasives (present application, page 3, line 6-17). However, such removal techniques also remove portions of the object surface, which can damage the fine features of the object, and are labor intensive.

Additionally, as discussed above, Leyden, which was filed in 1992, also discusses the need for smoothing object surfaces. However, the stereolithographic processes of Leyden are not suitable for the claimed vapor smoothing process of the present application (Leyden, col. 6, lines 56-68; col. 9, lines 34-39; and col. 11, lines 35-44). As such, the Leyden processes require a smoothing process, such as applying and curing an additional amount of the curable resin to fill in the surface discontinuities, to provide smooth surfaces (Leyden, col. 7, lines 1-15).

Despite the extended time period in which the fused deposition modeling technique has existed, Applicants assert that they are the first to substantially eliminate surface effect(s) in objects built with the fused deposition modeling technique with the use of the claimed vapor smoothing process. If the claimed process were otherwise obvious to one skilled in the art, as the Examiner erroneously contends, then Applicants question why the claimed process did not show up in the field prior to Applicants' development, despite the long-felt need for such low labor-intensive techniques. Accordingly, in addition to the reasons discussed above, Applicants

assert that the processes recited in claims 1, 21, and 43 of the present application present a solution to a long-felt need for efficiently smoothing the surfaces of objects built with the fused deposition modeling technique.

D. The Claimed Process Satisfies a Long-Felt Need for Substantially Eliminating Surface Porosity in Objects Built with the Fused Deposition Modeling Technique

Objects built with the fused deposition modeling technique are porous due to the build technique (Zinniel Decl., ¶ 10). The pores are created to provide a cushion in the build parameters when depositing materials to maintain dimensional accuracy of the objects (Zinniel Decl., ¶ 10). This is discussed in Batchelder, U.S. Patent No. 5,653,925, filed in September, 1995 (Zinniel Decl., ¶ 10).

It is known to those skilled in the art that object built with the fused deposition modeling technique are suitable for use as real, usable parts due to the strengths of the thermoplastic modeling materials. However, such objects are also porous, which allows fluids to pass through the walls of the objects, thereby potentially reducing the functionality of the objects to retain gases and liquids. This is demonstrated in the tests discussed in the Zinniel Declaration. For example, such objects may be less desirable for use as liquid vessels (e.g., a coffee cup) due to the porosity.

As such, there has been a long-felt need to eliminate the porosity of three-dimensional objects built by the fused deposition modeling technique, which may create water-tight objects that can withstand pressure buildup (Zinniel Decl. ¶ 11, and Medina Decl. ¶ 2). Yet, despite this long-felt need, Applicants assert that they are first to substantially eliminate the porosity in the objects at the object surfaces with the use of the claimed vapor smoothing process. If the claimed process were otherwise obvious to one skilled in the art, as the Examiner erroneously contends, then Applicants question why the claimed process did not show up in the field prior to Applicants' development, despite the long-felt need for sealed-walls objects.

In the Advisory Action, the Examiner stated that Applicants have not provided objective evidence that an art recognized problem existed in the art for a long period of time without solution regarding the elimination of porosity inherent to the fused deposition modeling technique. Applicants respectfully disagree with this contention and note that the porosity in three-dimensional objects built with the fused deposition modeling technique is discussed in

Batchelder, U.S. Patent No. 5,653,925, filed in September, 1995 (Zinniel Decl., ¶ 10). This is objective evidence that the need for water-tight objects existed since at least this date. Furthermore, the tests presented in the Zinniel Declaration provide objective evidence that such parts are indeed porous, thereby allowing fluids to pass through the walls of the three-dimensional objects. This is sufficient objective evidence to establish the long-felt need for substantially eliminating the surface porosity to provide as real, usable parts.

Moreover, the plastic articles that are smoothed pursuant to Joseph and Edmonds are typically built from an injection molding or similar technique, and do not exhibit such porosity issues. Thus, the plastic articles do not exhibit any reduction in surface porosity. Joseph and Edmonds do not recognize the issue that is presented by objects built with the fused deposition modeling technique. Accordingly, this combination of exposing the object to solvent vapors/reflowing the softened modeling material with the use of an object built with a fused deposition modeling technique provides substantial porosity elimination characteristics that are not present in, nor recognized by, the teachings of the cited references. Accordingly, in addition to the reasons discussed above, Applicants assert that the processes recited in claims 1, 21, and 43 of the present application also present a solution to a long-felt need for substantially eliminating porosity in objects built with the fused deposition modeling technique, at the object surfaces.

Accordingly, the cited references, taken alone or in combination, do not teach or render obvious the elements of claims 1, 21, and 43. As such, claims 1, 21, and 43 are not obvious over the specification of the present application (pages 1-4 and 8) as exemplified in part by Crump in view of Joseph, Edmonds, and/or Batchelder, and are allowable. Additionally, dependent claims 3, 8, 10, 11, 18, 19, 22, 27, 28, 33, 45, and 47-49, which depend from claims 1, 21, and 43 are also not obvious over the specification of the present application (pages 1-4 and 8) as exemplified in part by Crump in view of Joseph and/or Edmonds, and are separately allowable.

II. <u>Claims 4, 5, 23, and 46</u>

The Final Office Action also indicated that claims 4, 5, 23, and 46 stand rejected as being obvious over the specification of the present application (pages 1-4 and 8) as exemplified in part by Crump in view of Joseph or Edmonds, and Batchelder, and further in view of Dahlin. These rejections were maintained in the Advisory Action. As discussed above, independent claims 1,

21, and 43 are not obvious over the specification of the present application (pages 1-4 and 8) as exemplified in part by Crump in view of Joseph, Edmonds, and/or Batchelder, and are allowable.

The Examiner has not articulated that Dahlin provides any additional teachings to render the elements of claims 1, 21, and 43 obvious. As such, claims 1, 21, and 43, and dependent claims 4, 5, 23, and 46, which depend from claims 1, 21, and 43, are not obvious over the specification of the present application (pages 1-4 and 8) as exemplified in part by Crump in view of Joseph/Edmonds, Batchelder, and Dahlin.

III. Claim 20

The Final Office Action also indicated that claim 20 stands rejected as being obvious over the specification of the present application (pages 1-4 and 8) as exemplified in part by Crump in view of Joseph or Edmonds, and Batchelder, and further in view of Leyden. This rejection was maintained in the Advisory Action. As discussed above, independent claim 1 is not obvious over the specification of the present application (pages 1-4 and 8) as exemplified in part by Crump in view of Joseph, Edmonds, and/or Batchelder, and is allowable.

The Examiner has also not articulated that Leyden provides any additional teachings to render the elements of claim 1 obvious. As such, claim 1, and dependent claim 20, which depends from claim 1, are not obvious over the specification of the present application (pages 1-4 and 8) as exemplified in part by Crump in view of Joseph/Edmonds, Batchelder, and Leyden.

IV. Claims 18 and 48

The Final Office Action also indicated that claims 18 and 48 stand rejected as being obvious over the specification of the present application (pages 1-4 and 8) as exemplified in part by Crump in view of Joseph or Edmonds, and Batchelder, and further in view of Gessner. These rejections were maintained in the Advisory Action. As discussed above, independent claims 1 and 43 are not obvious over the specification of the present application (pages 1-4 and 8) as exemplified in part by Crump in view of Joseph, Edmonds, and/or Batchelder, and are allowable.

The Examiner has also not articulated that Gessner provides any additional teachings to render the elements of claims 1 and 43 obvious. As such, claims 1 and 43, and dependent claims 18 and 48, which depend from claims 1 and 43, are not obvious over the specification of the

present application (pages 1-4 and 8) as exemplified in part by Crump in view of Joseph/Edmonds, Batchelder, and Gessner.

CONCLUSION

With this response, Applicants and Appellants submit an earnest effort to address all issues raised in the Final Office Action of February 3, 2010, and the Advisory Action of May 24, 2010. For all the reasons advanced above, Appellants respectfully submit that claims 1, 3-5, 8, 10, 11, 18, 20-23, 27, 28, 33, 43, and 45-49 of this application are in condition for allowance, and that such action is earnestly solicited.

Respectfully submitted,

WESTMAN, CHAMPLIN & KELLY, P.A.

By: /Brian R. Morrison/

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CLAIMS APPENDIX

1. (Previously Presented) A method for making a three-dimensional object comprising the steps of:

providing an object built from a polymeric or wax modeling material using a fused deposition modeling technique, wherein the built object has an object surface formed of the modeling material, wherein the object surface has at least one surface effect due to the fused deposition modeling technique, wherein the at least one surface effect extends substantially across an entirety of the object surface, wherein the at least one surface effect is selected from the group consisting of a stair step effect, striation, a roughness due to errors in building the object, and a combination thereof, and wherein the object exhibits porosity due to the fused deposition modeling technique;

exposing the object to vapors of a solvent that transiently softens the modeling material at the object surface; and

reflowing the softened modeling material to substantially eliminate the at least one surface effect and to substantially eliminate the porosity of the object at the object surface.

2. (Canceled)

3. (Previously Presented) The method of claim 1, where the modeling material comprises a thermoplastic resin.

4. (Original) The method of claim 3, wherein the thermoplastic resin comprises at least about 50 weight percent of an amorphous thermoplastic selected from the group consisting of ABS, polycarbonate, polyphenylsulfone, polysulfone, polystyrene, polyphenylene ether, amorphous polyamides, acrylics, poly(2-ethyl-2-oxazoline), and blends thereof.

5. (Original) The method of claim 4, wherein the solvent is selected from the group consisting of methylene chloride, an n-Propyl bromide solution, perchloroethylene, trichloroethylene, and a hydrofluorocarbon fluid.

6-7. (Canceled)

8. (Previously Presented) The method of claim 1, and further comprising the step of:

selecting a length of time during which the object is to be exposed to the solvent vapors as a function of concentration of the solvent vapors, prior to the exposing step.

9. (Canceled)

10. (Previously Presented) The method of claim 1, and further comprising the step of:

masking selected portions of the object surface with a substance that will inhibit smoothing of the selected portions, prior to the step of exposing the object to the vapors of the solvent.

11. (Previously Presented) The method of claim 1, and further comprising building the object using the fused deposition modeling technique.

12-17. (Canceled)

18. (Previously Presented) The method of claim 1, and further comprising the step of:

suspending the object in a vessel containing the vapors of the solvent in a manner that substantially allows the entirety of the object surface to be exposed to the vapors of the solvent.

19. (Canceled)

20. (Previously Presented) The method of claim 1, and further comprising the steps of:

providing an initial object representation in a digital format, the initial object representation having a surface geometry; and

modifying the initial object representation to pre-distort certain features of the surface geometry, producing a modified object representation;

wherein the object built in the building step has a geometry defined according to the modified object representation; and

wherein the desired geometry attained following the exposing step approximately matches that of the initial object representation.

21. (Previously Presented) A method for making a three-dimensional object comprising the steps of:

providing an object built from a plurality of layers with a modeling material using a fused deposition modeling technique, wherein the object has an object surface, and wherein the plurality of layers create at least one surface effect extending substantially across an entirety of the object surface, the at least one surface effect being selected from the group consisting of a stair step effect, striation, a roughness due to errors in building the object, and a combination thereof, and wherein the object exhibits porosity due to the fused deposition modeling technique;

exposing the object to vapors of a solvent that transiently softens the modeling material at the object surface; and

reflowing the softened modeling material to substantially eliminate the at least one surface effect substantially across the entirety of the object surface and to substantially eliminate the porosity of the object at the object surface.

22. (Previously Presented) The method of claim 21, where the modeling material comprises a thermoplastic resin.

23. (Original) The method of claim 22, wherein the thermoplastic resin comprises at least about 50 weight percent of an amorphous thermoplastic selected from the group consisting of ABS, polycarbonate, polyphenylsulfone, polysulfone, polystyrene, polyphenylene ether, amorphous polyamide, methyl methacrylate, poly(2-ethyl-2-oxazoline), and blends thereof.

24-26. (Canceled)

27. (Original) The method of claim 21, and further comprising the step of:

masking selected portions of the object surface with a substance that will inhibit smoothing of the selected portions, prior to the step of reflowing the surface.

28. (Previously Presented) The method of claim 27, wherein the masking substance is applied using an automatic process selected from the group consisting of a jetting process and a fused deposition modeling process.

29-32. (Canceled)

33. (Previously Presented) The method of claim 21, wherein the solvent is selected from the group consisting of methylene chloride, an n-Propyl bromide solution, perchloroethylene, trichloroethylene, a hydrofluorocarbon fluid, and combinations thereof.

34-42. (Canceled)

43. (Previously Presented) A method for treating a three-dimensional object built with a modeling material using a fused deposition modeling technique, the method comprising:

providing the three-dimensional object to a vessel configured to contain vapors of a solvent, wherein substantially an entire exterior surface of the three-dimensional object comprises at least one surface effect caused by the fused deposition modeling technique, wherein the at least one surface effect is selected from the group consisting of a stair-step effect created by layering of a plurality of layers of the modeling material, striation created by formation of roads of the modeling material, surface roughness created by errors in the building of the three-dimensional object, and a combination thereof, and wherein the object exhibits porosity due to the fused deposition modeling technique;

placing the three-dimensional object in the vessel in a manner that exposes substantially the entire exterior surface of the three-dimensional object to the vapors of the solvent, wherein the vapors of the solvent transiently soften the modeling material across the entire exposed exterior surface of the three-dimensional object; and

reflowing the softened modeling material to substantially eliminate the at least one surface effect across the entire exposed exterior surface and to substantially eliminate the porosity of the object at the object surface.

44. (Canceled)

45. (Previously Presented) The method of claim 43, where the modeling material comprises a thermoplastic resin.

46. (Previously Presented) The method of claim 45, wherein the thermoplastic resin is selected from the group consisting of ABS, polycarbonate, polyphenylsulfone, polysulfone, polystyrene, polyphenylene ether, amorphous polyamides, acrylics, poly(2-ethyl-2-oxazoline), and blends thereof.

47. (Previously Presented) The method of claim 43, wherein the solvent is selected from the group consisting of methylene chloride, an n-Propyl bromide solution, perchloroethylene, trichloroethylene, a hydrofluorocarbon fluid, and combinations thereof.

48. (Previously Presented) The method of claim 43, wherein placing the three-dimensional object in the vessel comprises suspending the three-dimensional object in the vessel.

49. (Previously Presented) The method of claim 43, and further comprising masking selected portions of the exterior surface with a substance that will inhibit smoothing of the selected portions.

EVIDENCE APPENDIX

1. Enclosed with this Appeal Brief is a copy of the Declaration of Fransisco Medina under C.F.R. § 1.132, filed by Applicants on March 27, 2009. The Examiner entered the Medina Declaration in the June 19, 2009 Office Action, as indicated in the last paragraph on page 10 of the June 19, 2009 Office Action.

2. Enclosed with this Appeal Brief is a copy of the Declaration of Robert L. Zinniel under C.F.R. § 1.132, filed by Applicants on November 18, 2009. The Examiner entered the Zinniel Declaration in the February 3, 2010 Final Office Action, as indicated in the first sentence on page 9 of the February 3, 2010 Final Office Action.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor :	William R. Priedeman, Jr.	
Appln. No.:	10/511,784	Confirmation No.: 4209
Filed :	October 15, 2004	Group Art Unit: 1791
For :	Smoothing Method For Layered Deposition Modeling	Examiner: John L. Goff II
Docket No.:	S697.12-0065	

DECLARATION OF FRANCISCO MEDINA UNDER C.F.R. § 1.132

Commissioner For Patents
P.O. Box 1450
Alexandria, VA 22313-1450

FILED ELECTRONICALLY ON
MARCH 27, 2009

The enclosed Declaration letter from Francisco Medina, signed pursuant to 35 U.S.C. § 1001, is submitted under C.F.R. § 1.132 in support of the supplemental amendment filed herewith.

Respectfully submitted,

WESTMAN, CHAMPLIN & KELLY, P.A.

By: /Brian R. Morrison/

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Minneapolis, Minnesota 55402-3319
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March 25th, 2009

Brian Morrison

Westman, Champlin and Kelly

Mr. Morrison,

My name is Francisco Medina I am the Center Manager of the W.M Keck center of 3D Innovation at the University of Texas at El Paso (UTEP). I received my B.S. Mechanical Engineering in May of 2000 and a M.S. in December of 2005 from UTEP and I am currently pursuing a MBA with focus on Finance. I have been involved in the Rapid Prototyping (RP) and Rapid Manufacturing (RM) area since 2001 when the University acquired its first FDM 3000. I hold a Rapid Technologies and Additive Manufacturing (RTAM) Masters level certificate from the Society of Manufacturing Engineers (SME) since May 2006. My work in the Rapid Prototyping area has been published in different journals and conference proceedings including the Solid Free-Form Fabrication Symposium, the Stratasys Users' Group Conference, and the SME Rapid Prototyping & Manufacturing Conference, obtaining different awards such as the 1st Place at the Stratasys Users Group Conference Part Competition, with the entry entitled "Rapid Manufacturing of an Airplane Window Shade," (*2007 Stratasys Users Group Meeting*, Charlotte, NC, September 3-5, 2007), and the 1st Place at the 3D Systems Users Group Advanced Concepts Technical Competition, with an entry entitled "Multi-Material Stereolithography," (*2007 3D Systems Users Group Conference*, Daytona Beach, FL, March 18-22, 2007). Additionally I have been recognized by Emerald Group Publishing as Outstanding Paper and received the Emerald Literati Network Awards for Excellence 2007 and awarded the 2004 Dick Aubin Distinguished Paper Award for the 2004 Rapid Prototyping and Manufacturing Conference (selected by Rapid Technologies and Additive Manufacturing Committee of the Society of Manufacturing Engineers)

My relationship with Stratasys goes back to 2001, I have participated in the Stratasys Users Group Meetings, I have provided assistance in finding new applications for FDM technologies, and I often collaborate with their Applications Engineering Department in different projects. In the past, I have prepared and given presentations for their Sales Kick-off Meetings, and I have presented informative sessions in other Rapid Prototyping technologies to their Sales force. Currently I am assisting their Applications Engineering Group, and I am a beta account user on the new vapor smoothing technology. As 3D parts manufactured with RP/RM technologies have surface effects across the entire exterior surface of the part, due to the layered nature of RP/RM technologies, the vapor smoothing process reduces these surface effects. Surface effects such as stair stepping along curved or sloped surfaces and striations or roads along vertical or horizontal surfaces, are improved through vapor smoothing as the process smoothes the entire exposed area. Furthermore, as RP/RM parts have an intrinsic porosity, the vapor smoothing process exhibits potential to seal the exposed area with progressive vapor exposures ultimately creating water-tight 3D parts that can withstand pressure buildup. As a beta user, I understand that the vapor smoothing technology is being patented and I have no financial interest in the outcome of this patent.

If you need further information, please do not hesitate to contact me.

"I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statement were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon."

Francisco Medina

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor :	William R. Priedeman, Jr.	
Appln. No.:	10/511,784	Confirmation No.: 4209
Filed :	October 15, 2004	Group Art Unit: 1791
For :	Smoothing Method For Layered Deposition Modeling	Examiner: John L. Goff II
Docket No.:	S697.12-0065	

DECLARATION OF ROBERT L. ZINNIEL UNDER C.F.R. § 1.132

I, Robert L. Zinniel, state:

1. I am a product development engineer at Stratasys, Inc. in the field of production of plastic parts, including rapid prototyping/manufacturing processes and injection molding processes. I am an employee of Stratasys, Inc., the assignee of U.S. Patent Application No. 10,511/784. As a result, I have an interest in the outcome of this patent application.

2. I conducted a porosity test to show that (1) three-dimensional (3D) objects built with a deposition-based layered manufacturing technique, such as with a fused deposition modeling system, are necessarily porous due to the build technique, and (2) the vapor smoothing process taught in U.S. Patent Application No. 10/511,784 (the current patent application) for smoothing the surfaces of the 3D objects also necessarily reduces or eliminates surface porosities of the 3D objects.

3. The porosity experiment initially involved building three identical 3D objects with a fused deposition modeling system from a yellow-colored, acrylonitrile-butadiene-styrene (ABS) thermoplastic copolymer. The 3D objects were built from the same digital model and under the same operating conditions. After being built, each 3D object had striation and stair-step effects due to the build technique, which covered the entire surface of the given 3D object. This is shown in Image 1 in Appendix A-1, which is representative of both 3D objects that were built.

4. One of the 3D objects was then placed in a vapor chamber that contained vapors of a normal-propyl bromide solvent. This exposed the 3D object to the solvent vapors, which softened the ABS material at the object surface and caused the ABS material to reflow to the smooth the entire surface of the 3D object. This is shown in Image 2 in Appendix A-1.

5. Another one of the 3D objects was then hand sanded with 120-grit sandpaper until the exterior surface was smooth. This is shown in Image 3 in Appendix A-2.

6. Each 3D object was then subjected to a porosity test. The non-vapor smoothed 3D object represented a 3D object prior to vapor smoothing and the vapor smoothed 3D object represented the same 3D object after being vapor smoothed. I ran this experiment with separate 3D objects rather than with the same 3D object before and after vapor smoothing to reduce the burden of repeating the porosity test. The results of the porosity test would be the same in either situation.

7. Image 4 in Appendix A-3 shows the equipment used for the porosity test. The non-vapor smoothed 3D object was placed on the air seal base block such that the flange portion of the 3D object rested on the base block and the dome portion of the 3D object extended over the center opening of the base block. The air seal top ring was then place over the flange portion of the 3D object such that the dome portion of the 3D object extended through the center opening of the top ring. The top ring was then tightened against the flange portion of the 3D object and the base block with four screw-type fasteners. This created an air tight seal between the top plate, the flange portion of the 3D object, and the base block.

8. The bottom end of the base block was connected with an air tight seal to the air tube. The air tube was also connected to the pressurized air line, which was controlled by a pressure gauge to adjust the pressure of air flowing into the base block. The mounted 3D object was then immersed in the container of water such that the 3D object was completely submerged in the water. The air line was then opened to a pressure of about 6 psi to introduce pressurized air to the mounted 3D object.

9. Image 5 in Appendix A-4 is a still photograph of the mounted and submerged 3D object after the pressurized air was introduced. The pressurized air flowed through the 3D object to produce a substantial amount of air bubbles in the water. The air bubbles were due to air passing through pores in the 3D object. If any bubbles were formed due to air leaking through the air seals between the 3D object, the top ring, and the base block, they would have accounted for a very small amount of the air bubbles shown in Image 5.

10. The pores in the 3D object were due to the deposition-based layered manufacturing technique used to build the 3D object. 3D objects built with a deposition-based layered manufacturing technique, such as with a fused deposition modeling system, are necessarily porous due to the build technique. The pores are created to provide a cushion in the build parameters when depositing the ABS material to maintain the dimensional accuracy of the 3D object. This is discussed in U.S. Patent No. 5,653,925, issued in August 1997, and is recognized by people skilled in the art of rapid prototyping/manufacturing processes.

11. I then ran the same test on the vapor smoothed 3D object. Image 6 in Appendix A-4 is a still photograph of the mounted and submerged 3D object after the pressurized air was introduced. In this case, the pressurized air did not flow through the 3D object and only a single stream of air bubbles slowing escaped, probably due to air leaking through the air seals between the 3D object, the top ring, and the base block. This is because, in addition to smoothing the 3D object surface, the vapor smoothing process also eliminated the surface porosity of the 3D object. This sealing effect at the surface of the 3D object would be recognized by people skilled in the art of rapid prototyping/manufacturing processes based on the teachings in U.S. Patent Application No. 10/511,784 (the current patent application).

12. I then ran the same test on the hand sanded 3D object, but with an air line pressure of about 5 psi. Image 7 in Appendix A-5 is a still photograph of the mounted and submerged 3D object after the pressurized air was introduced. In this case, the pressurized air also flowed through the 3D object to produce a substantial amount of air bubbles in the water. The air bubbles were due to air passing through pores in the 3D object. So, while the hand sanding did smooth out the exterior surface of the 3D object, it did not reduce or eliminate the surface porosity.

13. I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statement were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Robert L. Zinniel

Date: 11/16/09

Appendix A-1

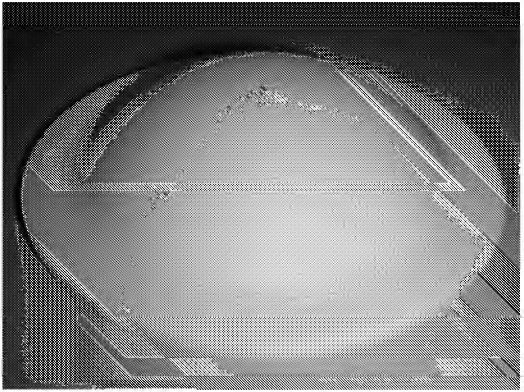
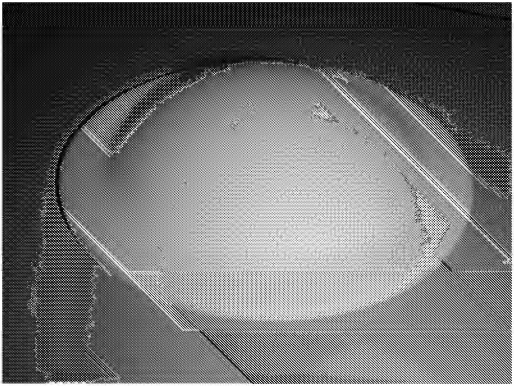


Image 1

Image 2



Appendix A-2

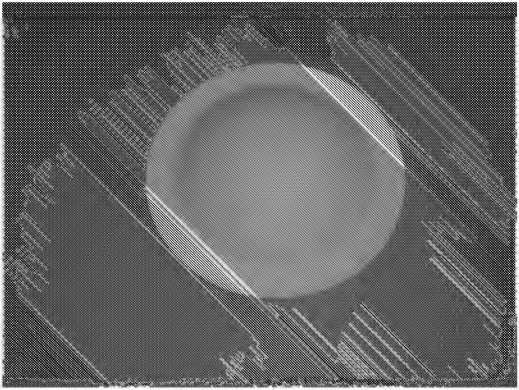


Image 3

Appendix A-3

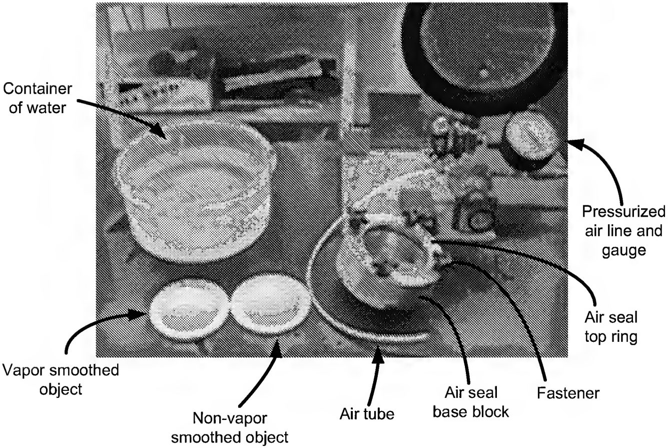


Image 4

Appendix A-4

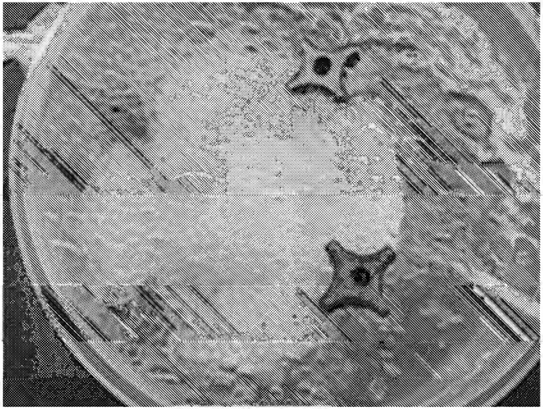


Image 5

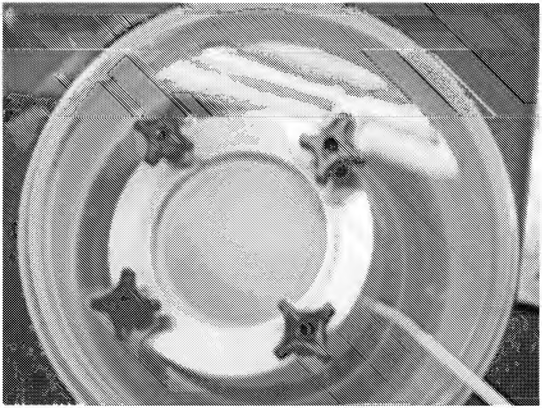


Image 6

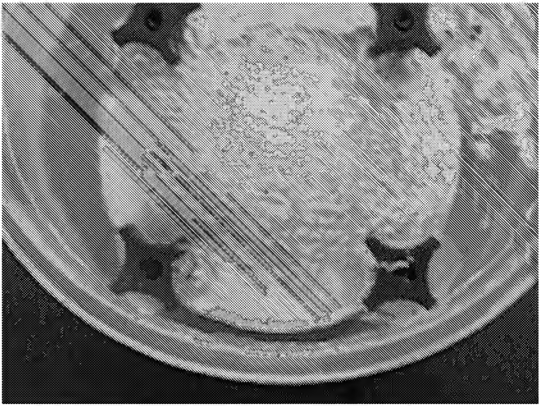


Image 7

RELATED PROCEEDINGS APPENDIX

None.